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RAFFERTY-ALAMEDA PROJECT

ENVIRONMENTAL IMPACT STATEMENT

Souris Basin Development Authority

CHAPTER 9

SOILS

RAFFERTY/ALAMEDA ENVIRONMENTAL IMPACT STATEMENT

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Chapter 17 Recreation
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(b) - Lutheran Bible Camp
(c) - Dr. Mainprize Regional Park

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SOILS

INTRODUCTION

The soils program is an important component of the baseline information gathering process because of the need to evaluate the terrestrial environmental impacts of the proposed Rafferty and Alameda Reservoirs. The primary reason for soil characterization and monitoring is the direct/indirect relationships that exist between soil quality, crop land productivity, surface and groundwater quality, and human and animal health.

One concern relates to the creation of large water storage reservoirs. Soils in the proposed reservoir areas will undoubtedly contribute nutrients and perhaps trace element concentrations to the reservoir water. The potential impact of such contributions needs to be assessed with respect to water quality and dependent human, animal, bird and fish populations.

A moisture deficit for crop production exists in the area. The Conservation and Development Branch of the Saskatchewan Department of Agriculture responded to interest in irrigation in this area in the mid 1960s by conducting a preliminary study on the availability of shallow groundwater. The result of that study indicated that sufficient quantities of groundwater for irrigation were not readily available.

The soil assessment and mapping program undertaken for this study was designed to allow for:

- the definition of nutrient and mercury levels in soils to be included in the potential reservoir area; and
- the agricultural land classification for both dryland and irrigation farming near the reservoirs.

METHODS

Soils were mapped to the subgroup level following Canada Soil Survey Committee (CSSC 1978) criteria at a scale of 1:50,000 (working map). The

mapping program covered an area approximately 3 km on either side of the proposed Rafferty and Alameda Dams and Reservoirs.

Surficial geology maps, soil survey maps and reports, and aerial photographs were reviewed and augmented by field investigation prior to finalizing the soils map. Soil map units (when defined) were interpreted for dryland and irrigated agricultural capabilities following the terms and procedures specified by the Government of Canada Canada Land Inventory (CLI 1965), and Bennett et al. (1983) with reference to Government of Canada (1967).

The soils of the Weyburn-Estevan area have been surveyed by Mitchell et al. (1944) and more recently by the Saskatchewan Institute of Pedology (SIP). The latter survey began in the mid 1970's and resulted in the presentation of soils maps (now available at a scale of 1:100,000). The maps were structured for use by agricultural representatives and landowners. Consequently, they lack taxonomic detail necessary for the application of interpretive ratings (D. Anderson, pers. comm.). Since a published map which presents taxanomic detail is not yet available, a brief field trip to the area was required to supplement available information and allow for map unit interpretation.

The field inspection was comprised of shovel and hand auger soil profile exposures at 104 inspection sites. The exposures represented soil units identified between the hamlet of Roche Percee in the southeastern part of the Study Area and the city of Weyburn to the northwest. The following soil properties were recorded at each site:

- texture;
- horizon depth;
- structure;
- colour;
- consistence;
- root depth and characteristics;
- effervescence;

- o stoniness;
- o surface erosion if evident;
- o present land use; and
- o vegetation cover.

Samples from each major soils horizon were placed in plastic bags and transported to the laboratory for analysis. Soil analyses included determination of pH, ECe, soluble and extractable cations, cation exchange capacity (CEC), texture, organic carbon, SAR, and total sulphur. The methods followed in soil laboratory analysis are presented in Table 1.

To assess the impact of reservoir flooding on surface water quality, soils within the potential reservoir area were sampled and analyzed for available nitrogen, phosphorus, potassium and total mercury levels. Composite soil samples which represented the top 15 cm of surface soil at eight locations within the proposed reservoir were analyzed for those parameters specified in Table 1.

Assessment of land irrigation suitability followed Bennett, et al. (1983). The system for irrigation suitability classification referenced by the Saskatchewan Water Corporation (1985) was not yet finalized (Eilers, Pers. Comm. 1986).

The base line soil study and subsequent recommendations were derived from existing information. The sources of information were:

- o Soils of the Regina Map Area, Saskatchewan Institute of Pedology (1965);
- o Agroclimatic Atlas for Canada (1976);
- o Soil survey of the area (Anderson, pers. comm. 1985);
- o Canada Land Inventory maps for the Weyburn area, Government of Canada (1965);
- o A report on irrigation potential in the area prepared for the Saskatchewan Water Resource Corporation (1985);
- o Buffer curves for soils in the Rafferty reservoir area.

Data derived from the above sources were applied to the Reservoirs to describe current conditions and to evaluate possible developments and changes resulting from the proposed development activities.

TABLE 1

Soil Analytical Procedures

Parameter Measured	Methodology
Particle size	U.S. Government
Total sulphur	Association of Analytical Chemists (1975)
Available	
Potassium	McKeague Sec. 4.51
Nitrogen	McKeague Sec. 4.44
Phosphorous	McKeague Sec. 4.44
Reaction (pH)	McKeague Sec. 3.14
Salinity (EC_e, mS/cm)	McKeague Sec. 3.21
Soluble Cations and Sodicity (SAR)	McKeague Sec. 3.21, 3.26
Extractable Cations	McKeague Sec. 3.321
Cation Exchange Capacity	McKeague Sec. 3.321
Buffering Capacity	Tisdale and Nelson (1975)
Organic Matter	McKeague Sec. 3.613
Trace Element - Mercury	A.A. Levinson (1974)

RESULTS AND DISCUSSION

SOILS AND GEOLOGY

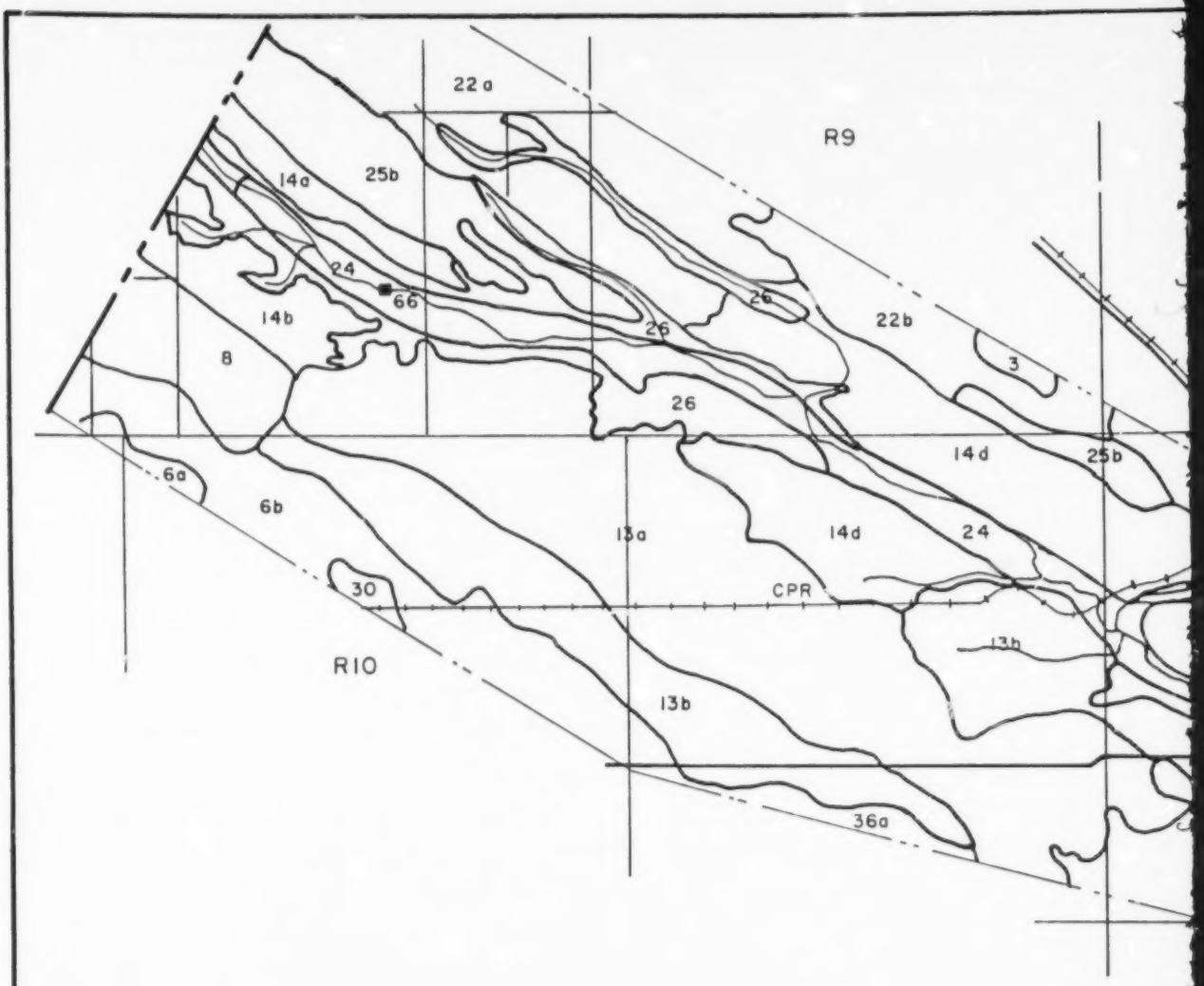
1 Rafferty Project Area

The Study Area is situated within the Dark Brown Soil Zone of Saskatchewan. Dark Brown soils develop under mixed grass prairie vegetation. Climatic characteristics necessary to lead to the development of Dark Brown soils impose moderate soil moisture deficit limitations on agricultural production.

The Dark Brown soils in the Study Area have developed on a number of parent materials of glacial origin. Evidence of glacial meltwater activity typifies the area: Christiansen (1978) showed a glacial ice front paralleled the Souris River Valley approximately 15,500 years ago. Meltwater from the ice flowed southeast along the Souris River Valley and eventually ended up in Lake Souris (once found in southwestern Manitoba). The glacial advance and retreat left a number of parent materials, including morainal blanket, morainal veneer, and fluvial gravels and sands associated with deglaciation and glacial runoff. In addition, weathered bedrock or saprolite exist along the Souris River Valley walls. More recent deposits of river alluvium can be found in the Souris River Valley floor. The soils associated with these local parent materials are defined in more detail on Figure 1, Figure 2 and the accompanying map legend.

.1 Morainal Blanket

The ice sheet left a morainal blanket north and east of the Souris River that extends from Weyburn beyond Estevan. The morainal blanket consists of unsorted or resorted boulder clay till. The topography is undulating to hummocky with a succession of knolls and depressions in some areas. The soils developed on this till are slightly to moderately stony, well drained in mid to upper slope positions and imperfectly to poorly drained in depressions. Although Chernozemic (grassland) soils dominate the area, they tend to be solonetzic (i.e. having a hard, compact B horizon underlaid by a more saline or calcareous C horizon). Depressional areas may be dominated by soils which are considered to be morphologically Solonetzic.



LEGEND

BOUNDAR
RESERVO

■ RIVER VALLEY BOTTOM SOIL/SEDIMENT SAMPLE SITE

— SOIL UNIT BOUNDARY

5Eb
- L% SLOPE RANGE
- MAP SYMBOL

1000 0 2000 METE

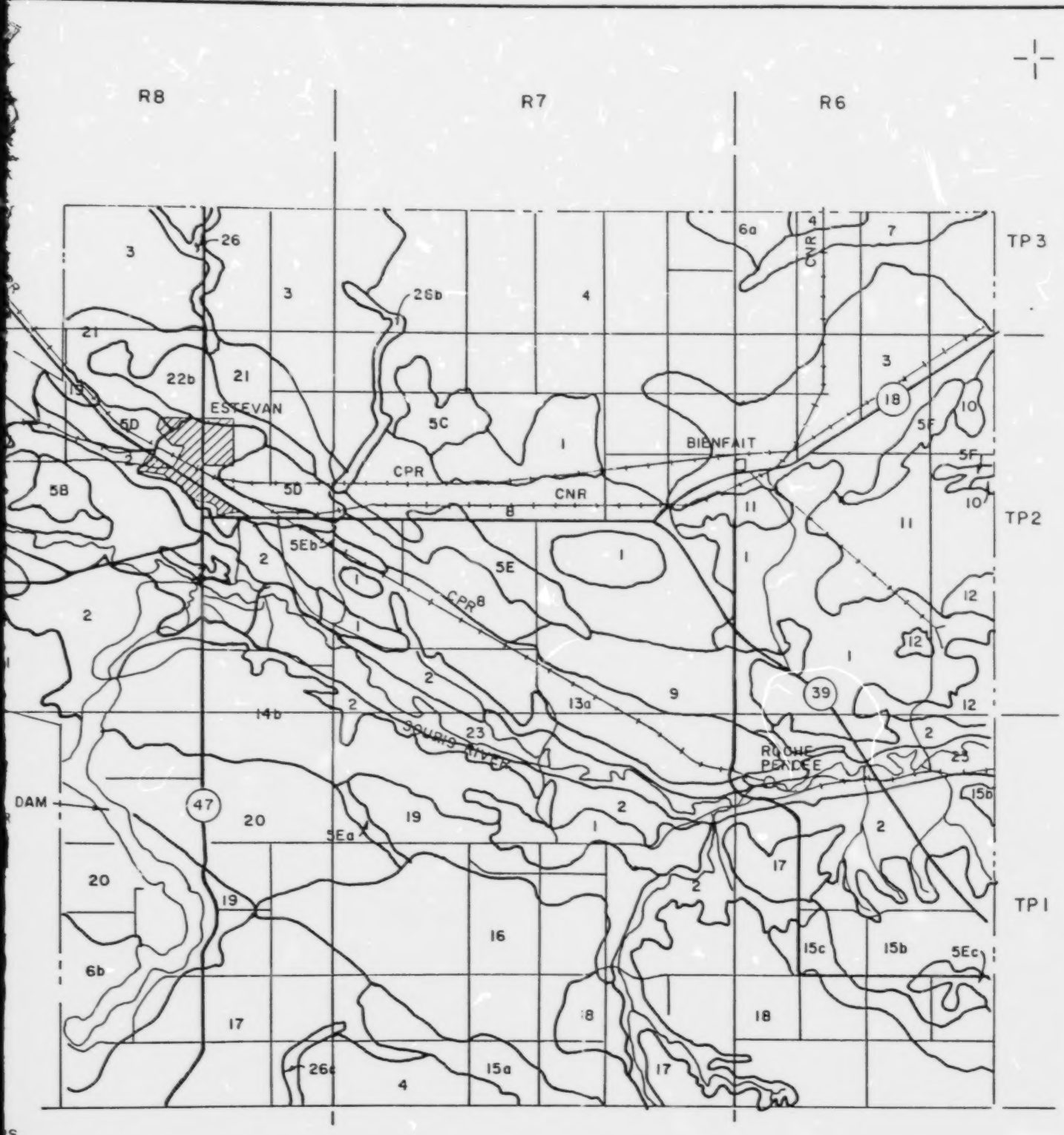


FIGURE 1

LOWER RAFFERTY
SOIL CLASSIFICATION
RAFFERTY RESERVOIR

Legend Figures 1 and 2

MAP SYMBOL	SOIL			ASSOCIATED LANDFORMS			INTERPRETATIONS	
	CLASSIFICATION	SURFACE TEXTURE	DRAINAGE	PARENT MATERIAL	SURFACE EXPRESSION	% SLOPE RANGE	AGRICULTURE CAPABILITY	IRRIGATION CLASS
1	2	3	4	5	6	7	8	9
1	Orthic Regosol	L-CL	Moderately well	Anthropogenic	Ridged	50 - 70	7r	6 ST 42
2	Orthic Regosol	L-CL	Moderately well	Very stony fine - moraine veneer over saprolite	Steep	75	7r	6 ST 44
3	Solonetzic Dark Brown, Dark Brown Solod and Gleyed Dark Brown Solonetz	L-CL and SICL	Moderately well to imperfect	Moderately to slightly stony fine-loamy moraine	Gently undulating	1 - 3	$3^{8}s5^{2}w$	2 ST 22
4	Solonetzic to Orthic and Calcareous Dark Brown, Gleyed Dark Brown Solod	L-CL	Moderately well to imperfect	Moderately stony fine-loamy moraine	Undulating to Hummocky	2 - 9	$3^{8}s5^{2}w$	2 ST 22
5 A	Solonetzic Dark Brown to Orthic Dark Brown	L	Moderately well to imperfect	Slightly stony loamy to fine-loamy reworked moraine	Undulating to roughly undulating dissected	2 - 5	2c	2 ST 12
B	Solonetzic and Orthic Dark Brown, Dark Brown Solodized Solonetz	L-CL	Well	Slightly stony loamy to fine-loamy reworked moraine	Undulating to roughly undulating dissected	a LT 2 b 2 - 5	3s	2 ST 22
C	Solonetzic and Dark Brown Orthic Dark Brown	L	Well to poor	Slightly stony loamy to fine-loamy reworked moraine	Undulating	LT 2	3s	2 ST 22
D	Solonetzic Dark Brown and Dark Brown Solodized Solonetz	L-SICL	Well to poor	Slightly stony loamy to fine-loamy reworked moraine	Gently undulating	1 - 3	3s	2 ST 22
E	Solonetzic Dark Brown and Gleyed Dark Brown Solodized Solonetz	CL	Well to poor	Slightly stony loamy to fine-loamy reworked moraine	Nearly level to gently undulating	a LT 2 b 1 - 3 c 2 - 5	$3s^{8}s^{7}w$	5 ST 42
F	Dark Brown Solodized Solonetz and Gleyed Saline Dark Brown Solodized Solonetz	CL	Well to poor	Slightly stony loamy to fine-loamy reworked moraine	Gently undulating	1 - 3	$4^{8}s5^{2}w$	5 ST 42
G	Solonetzic Dark Brown, Dark Brown Solodized Solonetz and Dark Brown Solod	CL	Well to imperfect	Moderately stony fine-loamy moraine	Gently undulating to hummocky	a 1 - 3 b 2 - 5	3s	2 ST 22
7	Solonetzic Dark Brown and Saline Dark Brown Solodized Solonetz	CL	Well to imperfect	Slight- to moderately stony fine-loamy moraine	Gently undulating	1 - 3	$3^{8}s5^{2}w$	2 ST 22
8	Solonetzic Dark Brown, Calcareous and Orthic Dark Brown, and Gleyed Saline Dark Brown Solodized Solonetz	L-SL	Well to imperfect drained	Moderately stony coarse-loamy to fine-loamy moraine	Undulating to hummocky	2 - 9	3s	2 ST 22
9	Orthic Dark Brown to Solonetzic Dark Brown	SL(g)	Well	Sandy to moderately stony gravelly coarse-loamy moraine over fine-loamy moraine	Level to undulating dissected	2 - 5	3s	3 ST 33
10	Orthic Dark Brown to Calcareous Dark Brown and Solonetzic Dark Brown	SL	Well	Moderately stony fluvial veneer over coarse-loamy fine-loamy moraine	Gently rolling to hummocky	5 - 9	4s	2 ST 22
11	Orthic Dark Brown Calcareous Dark Brown Solonetzic Dark Brown, and Gleyed Saline Dark Brown Solodized Solonetz	SL-L	Well to imperfect	Moderately stony coarse-loamy fluvial veneer over moderately stony coarse to fine-loamy moraine	Undulating to hummocky	2 - 5	$3^{8}s5^{2}w$	2 ST 22
12	Orthic Dark Brown to Dark Brown Solodized Solonetz	L	Well	Extremely stony fine-loamy moraine	Undulating and dissected	2 - 5	$3^{5}s5^{5}y$	6 ST 34

Legend Figures 1 and 2

13	Orthic Dark Brown to Dark Brown Solodized Solonetz and Gleyed Saline Dark Brown Solodized Solonetz	L	well to imperfect	Extremely stony water worked loamy morainal veneer to blanket over fine-silty bedrock	Nearly level to dissected undulating	a LT 2 b 2 - 35	$5^{8}s3^{2}s$	6 ST 34
14	Orthic Dark Brown to Solonetzic Dark Brown	L-SL	well	Extremely stony water worked coarse-loamy to fine-loamy morainal veneer to blanket over fine-silty bedrock	Undulating to dissected	a LT 2 b 2 - 5 c 5 - 9 d 9 - 15	$5^{7}s4^{3}s$	6 ST 34
15	Dark Brown Solodized Solonetz to Dark Brown Solod	L	well	Sandy fluvial over coarse-loamy to fine-loamy saline morainal	Undulating to dissected	a 1 - 3 b 2 - 5 c 5 - 15	3s	3-4 S T 3 2-3
16	Dark Brown Solodized Solonetz to Dark Brown Solod, Gleyed Saline Dark Brown Solodized Solonetz	L-SL	well to poor	Coarse-loamy fluvial veneer to blanket over coarse-loamy to fine-loamy saline morainal	Undulating	1 - 3	$4^{8}s5^{4}w$	3 ST 32
17	Dark Brown Solodized Solonetz to Dark Brown Solod	SL-L	well	Coarse-loamy fluvial veneer over moderately stony fine-loamy saline morainal	Undulating to dissected	2 - 5	4s	3 ST 32
18	Dark Brown Solodized Solonetz to Dark Brown Solod and Gleyed Saline Dark Brown Solod	SL-SICL	well to poor	Coarse-loamy fluvial veneer over fine-loamy morainal	Undulating	1 - 3	$4^{7}s3^{3}w$	5 ST 42
19	Orthic Dark Brown	LS-SL	Rapid	Sandy to coarse-loamy fluvial blanket over fine-loamy morainal	Level to gently undulating	2	4s	5 ST 42
20	Orthic Dark Brown Gleyed Saline Dark Brown Solod	LS	Rapid to poor	Sandy to coarse-loamy fluvial veneer over fine-loamy morainal	Level to gently undulating	LT 2	$4^{8}s5^{2}w$	5 ST 42
21	Dark Brown Solodized Solonetz, Dark Brown Solod, Orthic Dark Brown, Calcareous Dark Brown, and Gleyed Saline Dark Brown Solod	L	well to imperfect	Moderately stony fine-loamy morainal	Undulating to hummocky	2 - 5	$3^{9}s5^{1}w$	2 ST 22
22	Orthic Dark Brown to Calcareous Dark Brown and Gleyed Dark Brown Solod	L	well drained	Moderately stony fine-loamy morainal	Dissected hummocky	a 2 - 5 b 5 - 9	$3^{9}s5^{1}w$	2 ST 12
23	Orthic to Cumulic Regosol	CL	well to imperfect	Fine-loamy fluvial	Nearly level to gently undulating and dissected	2	3s	3 ST 33
24	Gleyed Cumulic Regosol	CL	imperfect	Medium to fine-loamy fluvial	Nearly level to gently undulating	2	4w	3 ST 33
25	Orthic Dark Brown	SL	well	Coarse-loamy fluvial veneer over fine-loamy morainal	Dissected and hummocky	a 2 b 2 - 5	3s	3 ST 22
26	Gleyed Dark Brown Solodized Solonetz to Rego Dark Brown	CL	Poor	Fine-loamy to gravelly, excessively stony veneer over saprolite	Level in drainage bottom, steep valley sides	2	6s-7s	6 ST 42
27	Dark Brown to Solonetzic Dark Brown, Calcareous Dark Brown and Gleyed Saline Solodized Solonetz	SL	well to imperfect	Coarse-loamy fluvial veneer to blanket over fine-clayey morainal	Undulating	2	$3^{8}s5^{2}w$	3 ST 32
28	Orthic Dark Brown, Solonetzic Dark Brown and Calcareous Dark Brown	SL	well	Coarse-loamy fluvial veneer to blanket over fine-clayey morainal	Undulating	2 - 5	3s	3 ST 32
29	Orthic Dark Brown to Gleyed Saline Dark Brown	SL-G	well to imperfect	Gravelly and stony coarse morainal	Dissected	2 - 5	$4s^{8}s^{2}w$	4 ST 42
30	Orthic Dark Brown Calcareous Dark Brown	CL	well	Moderately stony fine-loamy morainal	Hummocky	5 - 9	4s	3 ST 23

Legend Figures 1 and 2

31	Orthic Dark Brown to Dark Brown Solodized Solonetz	L	well	Extensively stony fine-loamy morainal veneer over shale bedrock	Inclined	9 - 15	8 e	4 ST 42
32	Dark Brown Solod Solonetzic Dark Brown and Orthic Dark Brown	L-SL	well	Coarse-loamy fluvial veneer over fine-loamy morainal	Dissected to hummocky	a LT 2 b 2 - 5	3s	3 ST 32
33	Dark Brown Solod, Orthic Dark Brown and Gleyed Saline Dark Brown Solodized Solonetz	L-SL	Moderately well	Slightly to moderately stony fine-loamy morainal with a veneer of coarse fluvial in localized areas	Undulating	LT 2	$3^{9}s3^{1}w$	3 ST 32
34	Dark Brown Solodized Solonetz to Dark Brown Solod	C	Moderately well	Fine-clayey lacustrine	Level to undulating dissected	1	4s	4 ST 42
39	Solonetzic Dark Brown, Dark Brown Solod to Gleyed Dark Brown Solod	SL-CL	Moderately well	Coarse-loamy fluvial veneer in places over slightly to moderately stony fine-loamy morainal	Undulating	1 - 3	$3^{9}s3^{1}w$	3 ST 32
56	Orthic Dark Brown, Calcareous Dark Brown Solonetzic Dark Brown and Gleyed Saline Dark Brown Solod	L-CL	Moderately well	Moderately stony fine-loamy morainal	Undulating to Hummocky	a 2 - 5 b 5 - 9	$3^{9}s3^{1}e$	3 ST 23
57	Solonetzic Dark Brown Dark Brown Solod	FSL-SICL	well drained	Non-stony saline fine-silty to fine-loamy lacustrine	Undulating	LT 2	3s	3 ST 32
58	Orthic Dark Brown Calcareous Dark Brown	L	well	Moderately stony fine-loamy morainal	Dissected	LT 2	2e	2 ST 12

SOIL AGRICULTURE CAPABILITY

CLASS

1. No significant limitations in use for crops
2. Moderate limitations that restrict the range of crops or require moderate conservation practices
3. Severe limitations that restrict the range of crops or require special conservation practices
4. Severe limitations that restrict the range of crops or require special conservation practices, or both
5. Very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible
6. Capable only of producing perennial forage crops, and improvement practices are not feasible
7. No capability for arable culture or permanent pasture

Limitations

- c: adverse climate
- s: stoniness
- s: adverse soil characteristics
- t: adverse topography
- w: excess water

IRRIGATION CAPABILITY

CLASS

1. Excellent for irrigation with no significant limitation
2. Good irrigation land with moderate limitations
3. Fair for irrigation
4. Severe limitations for irrigation and requires special soil and water management practices.
5. Not suitable for irrigation under existing conditions b sufficient potential to warrant segregation for additi investigations or improvements
6. Non-irrigable

Description

SOILS

1. Excellent
2. Good
3. Fair
4. Non-irrigable

TOPOGRAPHY

1. Land suitable to develop for gravity or any other metho irrigation
2. Suitable for conventional sprinkler systems
3. Extremely rolling or hummocky terrain that is only irri with specialized sprinkler systems
4. Not suitable for irrigation

TP7
TP6
R13
58b
58a
5D
5E
36a
32b
13b
82
5A
37
5D
5F
35
58a
32d
34
5E
32a
96
97
31
32
33
92
5A
23
13b
33
32
36b
26
14d
14d
14d
85
19
33
38
LEGEND
RIVER VALLEY BOTTOM SOIL/SEDIMENT SAMPLE SITE
SOIL UNIT BOUNDARY
58b
% SLOPE RANGE
MAP SYMBOL
1000 0 2000 METERS

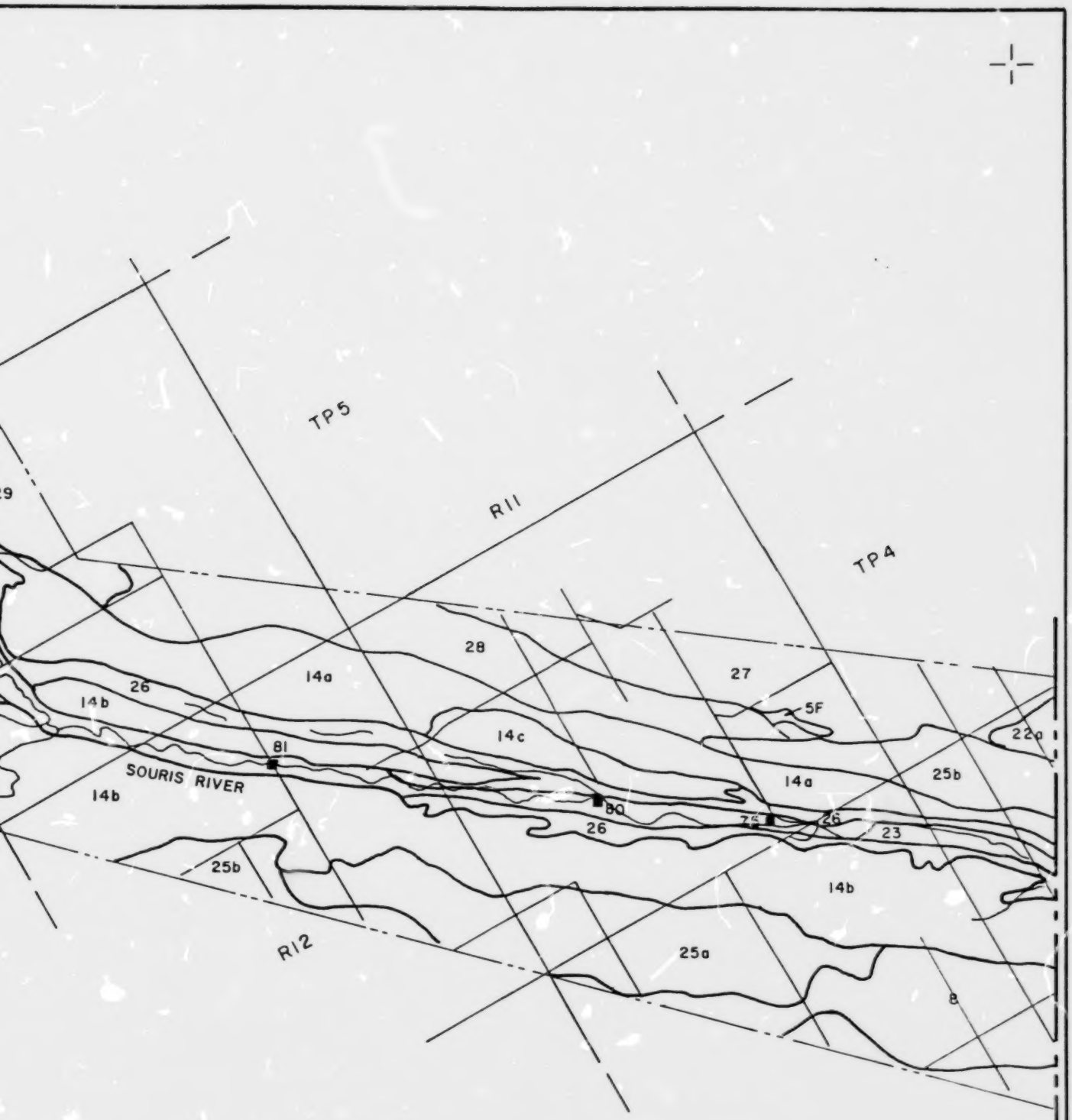


FIGURE 2
UPPER RAFFERTY
SOIL CLASSIFICATION
RAFFERTY RESERVOIR

Well to moderately well drained soils have moderately severe limitations to soil capability for dryland agriculture, due mainly to climatic and adverse soil characteristics (CLI Class 3s). Depressions are considered to have very severe limitations due to excess water (5w). Irrigation classifications range from 2 to 3 depending upon local soil and topographic conditions. These ratings would be reduced by 1 class, if natural surface drainage problems in depressions either interfered with irrigation development or could not be solved by systematic drainage.

Tables 2 and 3 define the physical and chemical properties of two Solonetzic Dark Brown soils found on morainal parent materials within the study area. The data show the soils to have a coarse-loamy textured surface which becomes fine-loamy with depth; organic carbon in the Ap horizon ranges from 2.4 percent to 3.3 percent; surface pH is mildly alkaline to neutral in reaction (Shewchuk et al. 1981); the soils are non-saline and non-sodic; calcium and magnesium cations dominate and the soils have a high cation exchange capacity. Total sulphur levels appear to be consistent with depth and do not show signs of excessive sulphur accumulation at the surface.

.2 Morainal Veneer

The affects of glacial meltwater erosion were most severe near the Souris River. Glacial meltwater removed a large percentage of the fine textured materials, leaving a shallow blanket of eroded till over soft bedrock along both sides of the river. The result of this erosion (on boulder till) was to concentrate the boulders at the surface and thus limit agricultural use of the soils developed on these materials to perennial forage crops. Soil capability classes are 5p and 4p.

The soils associated with these shallow and extremely stony morainal materials are both Chernozemic to Solonetzic in character. The topography varies from nearly level to dissected and undulating. Shallow depressions are dominated by imperfect to poorly drained Solonetzic soils. The soils do not have potential for irrigation and are identified as Irrigation Land Class 6.

TABLE 2

Physical and Chemical Properties of a Solonetzic Dark Brown Soil Developed on Fine-Loamy Morainal Material (M-1)

Soil Horizon	Depth (m)	Color Munsell (1975)	Texture				Structure	Organic Carbon %	Chemical Parameters												
			Sand	Silt	Clay	Class			pH	ECe mS/cm	Soluable					Extractable				CEC me/100g	Total S ug/g
											Na	K	Ca	Mg	SAR	Na	K	Ca	Mg		
											me/L					me/100g					
Ap	0.0 -0.15	10YR3/2	53	41	6	SL	mgrw	3.3	6.9	1.4	1.2	1.9	5.9	4.3	0.5	0.1	1.6	16.0	5.4	29.3	356
Ahe	0.15-0.19	10YR4/2	-	-	-	-	mplv	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AB	0.19-0.27	10YR3.2/3	-	-	-	-	msbm	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bnjtj	0.27-0.42	10YR3/3	48	32	20	L	mprs	-	6.2	0.7	2.0	0.3	2.2	3.0	1.3	0.1	.5	11.3	5.5	23.5	154
Ck	0.42-1.00	10YR5/3	46	27	27	L-SCL	-	-	7.7	1.3	1.8	0.4	5.5	6.4	0.8	0.2	0.4	-	-	15.2	472

Strong effervescence in Ck horizon.
- not determined

Structure

mgrw = medium granular weak
mplv = medium platy weak
msbm = medium subangular blocky moderate
mprs = medium prismatic strong

Source: Souris Basin Development Authority Background Report, 1986

TABLE 3

Physical and Chemical Properties of a Solonetzic Dark Brown Soil Developed on Course-Loamy to Fine-Loamy Morainal Material (M-6)

Soil Horizon	Depth (m)	Color Munsell (1975)	Texture				Structure	Organic Carbon %	Chemical Parameters													
			Sand	Silt	Clay	Class			pH	ECe mS/cm	Soluable					Extractable				CEC me/100g	Total S ug/g
											Na	K	Ca	Mg	SAR	Na	K	Ca	Mg		
											me/L					me/100g					
Ap	0.0 -0.20	10YR3/2	58	36	6	SL	mgrw	2.4	6.7	0.6	1.3	0.5	4.0	1.3	6.3	0.2	0.8	32.5	4.0	29.1	288
Ahe	0.20-0.23	10YR4/3	-	-	-	-	cpim	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bnjtj	0.23-0.58	10YR3.5/3	56	34	10	SL	mprs	-	7.5	0.6	1.8	0.1	2.4	1.9	1.2	0.2	0.4	14.6	8.8	28.9	30
BC	0.58-0.64	10YR3.5/3	-	-	-	-	msbm	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cca	0.64-0.80	10YR5/3	48	27	25	L	-	-	7.6	5.3	13.3	0.3	20.1	19.2	3.0	1.0	0.2	-	-	16.8	455
Ck	0.80+	10YR5/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Strong effervescence in Cca horizon.
- not determined

Structure

mgrw = medium granular weak
cpiw = coarse platy moderate
mprs = medium prismatic strong
msbm = medium subangular blocky moderate

Source: Souris Basin Development Authority Background Report, 1986

.3 Fluvial Veneer Blanket

The meltwater (from glacial ice) transported and deposited sandy and gravelly materials in two significant areas within the Study Area boundaries. These areas include lands immediately south and west of Midale. In addition, a large area south of the Souris River between Boundary Reservoir and Roche Percee is dominated by parent materials which vary from a coarse textured fluvial blanket to a veneer of overlying till. In some areas these fluvial materials have been reworked by wind.

The soils developed in these parent materials belong to both Chernozemic and Solonetzic Orders. Drainage can be rapid to poor dependent upon topographic position. Topography can range from level to hummocky. Dryland agricultural soil capability ranges from 3s to 4s on well drained sites to 5w in poorly drained depressions. Irrigation land classes range from 3 to 5 depending upon soil profile, soil drainage and soil moisture holding properties.

Table 4 presents the physical and chemical characteristics of a typical soil profile derived from aeolian/fluvial parent materials. The data show that these soils can be coarse in texture, structureless, and low in organic carbon. The soil pH at this site was slightly acid, non-saline, non-sodic and had a cation exchange capacity which suggests a medium acid-buffering capacity (Shewchuk et al., 1981). Total sulphur levels were below those reported for soils developed on morainal materials.

.4 Weathered Bedrock

The Souris River Valley walls include areas which were subject to the most severe erosion activity during deglaciation. Tertiary and Cretaceous sediments, and rock in the form of shales, sandstones, and coal are exposed along both sides of the river. The surface remains eroded and dissected, with steep slopes common throughout. In many areas, little or no vegetation has been established. The grey colored shales appear sodic and stone free except where boulders have remained after the glacial meltwater erosion of morainal cover.

The soils (where present) have virtually no capability for dryland or irrigated agriculture.

TABLE 4

Physical and Chemical Properties of a Rego Dark Brown Soil Developed on Aeolian Parent Material (M-7)

Soil Horizon	Depth (m)	Color Munsell (1975)	Texture				Structure	Organic Carbon %	Chemical Parameters													
			Sand	Silt	Clay	Class					Soluable					Extractable						Total S ug/g
									pH	ECe mS/cm	Na	K	Ca	Mg	SAR	Na	K	Ca	Mg	CEC me/100g		
											me/L					me/100g						
Ap	0.0 -0.2	10YR3/3	91	5	4	S	none	0.5	6.5	0.4	0.7	0.3	1.8	0.9	0.6	0.03	0.1	4.1	1.0	8.5	221
BC	0.2 -0.8	10YR4/4	89	6	5	S	-	-	6.3	0.3	0.6	0.1	1.6	1.5	0.5	0.04	0.7	4.4	1.3	9.6	110
Ah	0.8 -1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bm	1.0 -1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cca	1.10+	-	94	2	4	S	-	-	6.3	0.3	0.6	0.2	2.0	0.9	0.5	0.02	0.21	-	-	6.2	68

Weak effervescence in Cca horizon.
- not determined

Source: Souris Basin Development Authority Background Report, 1986

.5 River Alluvium

Recent deposits of river sediment lie immediately adjacent to the Souris River. Agriculturally exploitable river bottom lands extend from southeast of the village of Macoun to Roche Percee where forage and cereal grains are grown.

The valley from the Midale (Dead Lake) Dam northwest to Weyburn is less suitable for agricultural development. The upper reaches of the area are dominated by unsuitable topography with a narrow strip of native vegetation cover adjacent to the Souris River.

Areas suitable for agriculture (downriver from Midale Dam) are typical river bottom lands: the soils are Regosolic, fine-loamy in texture and well to imperfectly drained. The topography is level to undulating and dissected. Dryland capability ratings of 3s and 4w represent the area. An irrigated land class of 3 was assigned to most river bottom lands now under cultivation.

.6 Minespoil

The coal bearing bedrock of the Estevan area is described by Whitaker (1974) as Cretaceous Ravenscrag Formation. This bedrock is composed of interbedded sand, silt, clay and lignite with local carbonaceous, kaolinitic, concretionary and calcareous zones.

Coal mining activity removes the lignite and results in a mixture of glacial drift and Ravenscrag bedrock materials left in a series of ridges (spoil piles).

The spoil piles are a major feature of the area south, southeast and east of the city of Estevan. Much of the stripped overburden has been left in high ridges and to date remains unreclaimed and unvegetated. The mine spoil areas are useful only for rough grazing or wildlife habitat. Most of these spoil areas will be re-mined in the future to remove a lower seam of coal. Reclamation will follow removal of this coal seam.

.7 Agricultural Capability

The physical nature of surficial materials of glacial origin has been a major influence limiting the agricultural potential of soils found within the Study Area. These limitations include:

- o stony surficial materials;
- o poorly drained depressional areas;
- o shallow depth of overburden to bedrock; and
- o coarse textured fluvial materials with limited moisture holding capacity.

In addition, parent materials and pedogenic processes have combined to form soils with solonetzic characteristics. These solonetzic soil properties impose physical restraints on the rooting zone which limit crop potential and restrict soil internal drainage in low lying areas.

Overall, soil units identified in Figures 1 and 2 do not exceed a dryland agricultural capability class (CLI) of 2C. CLI class 2C soils are limited only by precipitation. However, the majority of the soils in the Study Area are CLI class 3 or lower with limitations other than climate. Near the Souris River Valley, soils were found to be CLI class 4 (severe limitations), class 5 (very severe limitations) and class 6 (capable of producing perennial forage crops only).

Those class 3 soils (within the Study Area) which are currently under dryland cultivation are similar in capability to the majority of soils mapped in the Weyburn map sheet (Government of Canada 1967).

More detailed information on the suitability of soils for irrigation in the Rafferty and Alameda Project Areas and downstream within the Souris River Valley is provided in the Irrigation section.

2 Alameda Project Area

.1 General Soils Description

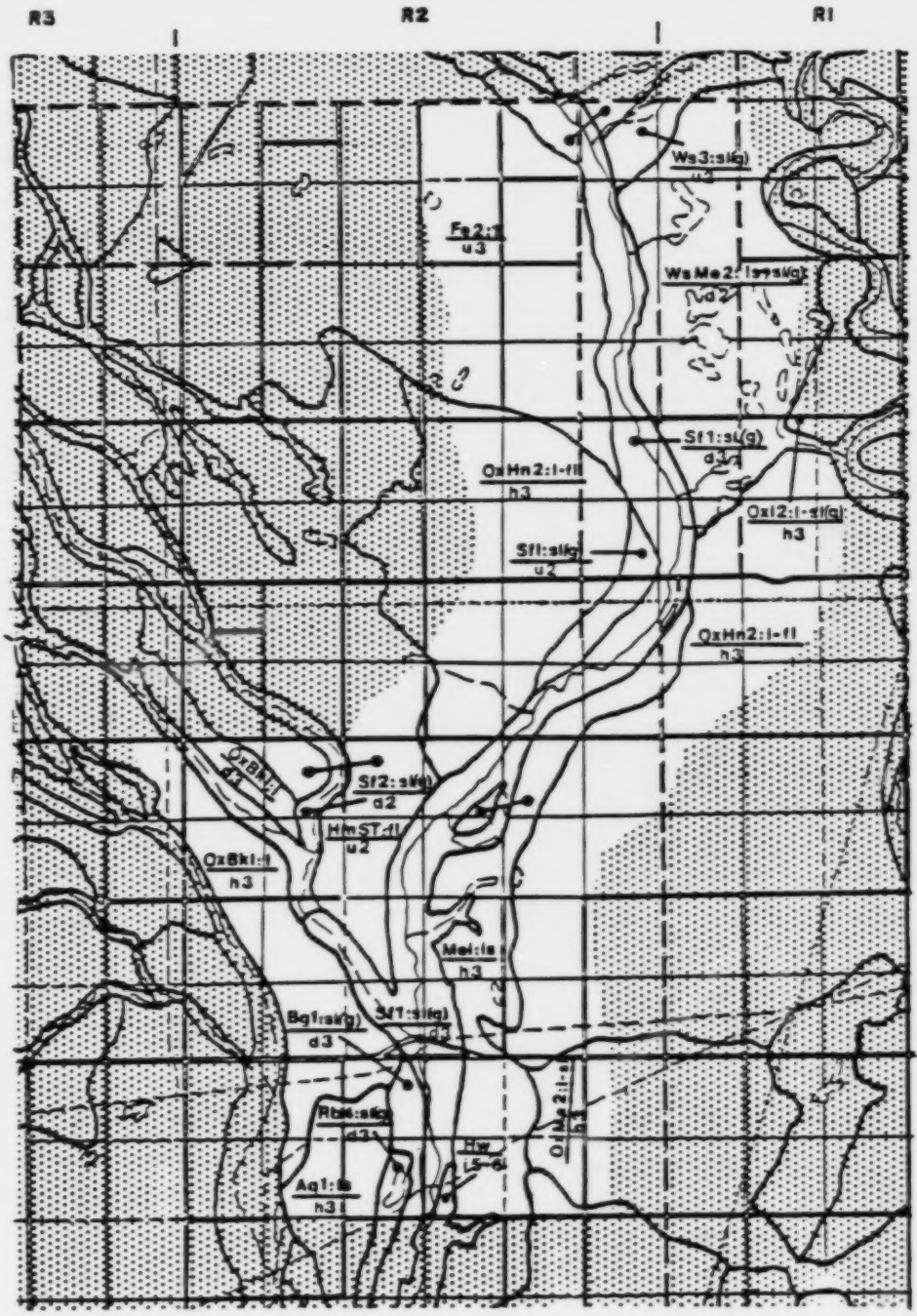
This area is located in the Black Soil Zone immediately east of the transition between the Dark Brown and Black Soil Zones. The soils have developed under a more humid climate than that associated with the Dark Brown Zone. Figure 3 shows the Alameda Project Area.

Six soil Associations are dominant in this area. These Associations include the Oxbow, Meota, Whitesand, Hamlin, Fremantle and Swift Creek. The following text briefly describes the soils, topography, approximately areal extent and the Canada Land Inventory classification of the major map units in the area as mapped by the Saskatchewan Institute of Pedology.

The Oxbow Association (Ox) and Hamlin (Hm) Association Complex consists of orthic and calcareous soils with orthic and calcareous Hm soils in depressional areas. The Oxbow soils are developed on till, while the Hamlin soils are developed on medium textured waterlain deposits. The surface texture of this complex is loam to fine sandy loam. The approximate area occupied by the complex is 4000 ha. The topography is described as roughly undulating hummocky lands with slopes of less than 5%. These lands are designated as Class 2 according to the CLI criteria which means that under good dryland management practices, these soils are moderately high to high in productivity.

The Meota (Me) Association is usually mapped as a lesser component of the Oxbow-Meota and Whitesand-Meota complex. The Meota Association consists mostly of Orthic Black soils developed from coarse textured sandy glacial-lacustrine deposit over till. It is shallowest on the knolls and increases with depth down the slope. It occupies some 1800 ha of land in the Alameda Project Area. The surface texture is loamy sand and its agricultural productivity class according to the CLI is a 4. Soils in this class are rated as having severe limitations for agricultural production.

The Whitesand Association (Ws) occupies about 2000 ha of land in the study area. It consists chiefly of Orthic Black soils developed from coarse textured glacio-fluvial deposits. The topography associated with this Association in the Study Area is described as undulating to roughly undulating with slopes of less



LEGEND:

SOIL MAP UNIT — Ox1 (SURFACE SOIL TEXTURE) / u2 (TOPOGRAPHY)

FIGURE 3

SOILS CLASSIFICATION
ALAMEDA RESERVOIR

than 5%. The CLI maps rate this area as class 5, which has very severe limitations with respect to dryland agricultural production.

The Hamlin Association (Hm) is comprised of Black Orthic soils, which are of medium texture and are developed on relatively coarse textured waterlain deposits over till. This Association is generally complexed with the Oxbow Association in the Study Area. Some 600 ha of this Association has been delineated in the Project area and is designated with a class 3 (CLI) rating. This land class has moderately severe limitations with respect to agricultural productivity.

The Fremantle (Fe) Association is made up of Black Orthic soils (loam) developed on silty resorted till and waterlain deposit over till. The topography is described as gently undulating, with slopes of less than 3%. The immediate Alameda Project Area contains approximately 2000 ha of Fremantle soils which fall into the class 3 category of the CLI classification system.

The Swift Creek Association (Sf) consists of mainly Orthic Black soils on variable deposits along local streams and are generally well drained. Occupying the lower positions along Moose Mountain Creek, these soils are rated as class 5 on the CLI map and therefore have very severe agricultural limitations and are not capable of sustained production of annual field crops.

The upland area is an undulating till plain covered with various depths of moderately coarse textured, water deposited materials. Due to the rather abrupt changes in texture between the coarse textured surface materials and the till, irrigation, if developed, will have to be carefully managed in order to prevent the creation of a perched water table.

.2 Agricultural Capability

The majority of the soils in the Alameda Project Area are limited in dryland agricultural production as a result of their coarse textured characteristics. Although about 40% of the area is considered reasonable dryland soils, CLI class 2, the remaining 60% of the area falls into CLI classes 3, 4 and 5 largely due to the limited moisture holding capacity of the coarse textured soils.

The creation of a permanent water body in Western Canada invokes the possibility of irrigation. The creation of a reservoir on Moose Mountain Creek will no doubt create an interest in irrigation development where none exists today. As with the Rafferty Project Area, irrigation potential associated with the Alameda Reservoir is discussed in a separate Irrigation section. Soil sampling and analysis of the soils for nutrients and mercury and boron levels in the Alameda Project Area will be undertaken in 1987; results will be presented to Saskatchewan Environment when available.

NUTRIENT AND MERCURY LEVELS IN SOILS AND SEDIMENTS ABOVE THE PROPOSED RAFFERTY DAM

Soil values for nitrogen, phosphorus, potassium and mercury (representative of what could become Rafferty Reservoir bottom sediments) are presented in Table 5. Mean available nitrogen levels (21 kg/ha), phosphorus (17 kg/ha), and potassium (1292 kg/ha) were reported for the Souris River Valley. These levels can be compared to the nutrient requirements for common crops grown in western Canada (Table 6). The comparison shows that the sediment levels of nitrogen and phosphorus are below those generally considered necessary for production of many common crops. Available potassium levels in soils along the river are well above required levels, a condition common to Western Canadian soils.

Mean total mercury levels (Table 5) are within background levels reported by Mills and Zwarich (1975) but represent the higher end of the expected range.

The difference between the mean soil parameter values presented in Table 5 and the actual levels of available nutrients or trace metal mercury is in a number of samples represented by the standard error of estimation. The data presented in Table 5 indicates that mean nitrogen, phosphorus, potassium, and mercury levels probably lie between 21 ± 6, 17 ± 7.6, 1292 ± 217, and 0.16 ± 0.2 kg/ha respectively at 68.26% confidence.

TABLE 5

Selected Soil Parameters Representing Soils of the Proposed Rafferty Dam Reservoir Sediment Area.

Site Number	Soil Parameter kg/ha (furrow slice) Available Nitrogen	Available Phosphorous	Available Potassium	Total Mercury[a]
66	35	65	1893	0.25
75	56	6	1221	0.20
80	15	7	1680	0.11
81	2	29	1792	0.11
85	20	7	941	0.11
92	2	17	851	0.11
96	13	7	174	0.11
97	22	0.4	1781	0.27
$\bar{x}$	21	17	1292	0.16
s	18	21	606	0.07
Standard Error	6	7.6	217	0.02

Monenco Analytical Laboratories

a) Mills and Zwarich (1975) reported background levels of mercury in western Canadian soils at 0.04 to 0.16 kg/ha.

TABLE 6

Nutrient Removal Potential of Common Western Canadian crops.

Crop	Yield			Nutrient removal kg/ha (Grain or straw)		
	kg/ha	bu/ac	tons/ac	Nitrogen	Phosphorous	Potassium
Wheat	2,690	40	-	95	17	52
Barley	3,228	60	-	101	16	51
Oats	3,060	80	-	112	18	71
Flax	1,255	20	-	61	9	42
Rapeseed	1,688	30	-	113	22	67
Grass	6,725	-	3	96	21	139
Alfalfa	8,967	-	4	278	24	160
Potatoes	33,750	-	15	252	36	302
Corn	13,451	-	6	156	38	119
Sugar Beets	33,750	-	15	179	21	120
$\bar{x}$				144	22	112
s				72	9	78
Standard Error				23	2.8	24

Source: Souris Basin Development Authority Background Report, 1986.

CONCLUSIONS

RAFFERTY PROJECT AREA

The soils within the Rafferty Reservoir Project Area are limited for both dryland and irrigated agricultural crop production by numerous factors which include:

- climate;
- stoniness;
- poor drainage in local depressions;
- topography;
- shallow depth to bedrock;
- coarse texture;
- solonetzic soil structure; and
- limited moisture holding capacity.

Soils presently under dryland agriculture within the Study Area generally have moderately severe limitations to severely limited capability for agriculture due to the above noted factors. This dryland capability class is typical to the Weyburn - Estevan area.

Lands suitable for irrigation development occur within the Souris River Valley downstream from the Midale Dam and, with few exceptions, in upland areas generally located at least one kilometre away from the valley wall. Irrigation potential associated with the Rafferty Reservoir is discussed in greater detail in a separate section.

ALAMEDA PROJECT AREA

The soils adjacent to the proposed Alameda reservoir consist of Orthic Black soils developed from till or coarse textured waterlain deposits on till.

The soils developed from the till are placed in the class 2 category of the Canada Land Inventory rating and are reasonably productive. The soils developed from the coarse textured material are placed in the class 4 and 5 categories and have severe restrictions with respect to agricultural production. The limitations of these soils are mainly due to their low water

holding capacities which results in extreme moisture stress on the crops during dry summers.

As discussed in the Irrigation section, the reservoir will provide a water supply for irrigation of some of the areas adjacent to the reservoir. The coarse textured soils would benefit substantially from irrigation however, irrigation water should be applied frequently and in small amounts. The low water holding capacity of the coarse textured soils could result in a shallow perched water table if over-irrigation occurred. As there is more suitable upland available for irrigation than available irrigation water, irrigation development should occur on the most favourable soils.

GENERAL

The Souris Basin Development Authority is not the proponent of any specific irrigation projects. Future irrigation proposals will be dealt with by Saskatchewan Agriculture, Saskatchewan Environment and the Saskatchewan Water Corporation on their own merits. Soil suitability, constraints, water requirements and proposed irrigation practices will be dealt with in detail when licenses are granted, as is now the case throughout the province.

Nutrient levels in sediments and soils which will become part of the Rafferty and Alameda Reservoirs are typical of those found in Western Canadian soils. Mercury levels in the same area are also within expected and known background limits. As discussed in the Irrigation section, additional baseline information on levels of mercury, boron and nutrients may be warranted prior to impoundment.